IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application

Applicant(s): Khalil C. Haddad
Case: 1
Serial No.: 09/803,801
Filing Date: March 12, 2001
Group: 2611
Examiner: Jason M. Perilla

Title: Shortening Impulse Response Filter (SIRF) and Design Technique Therefor

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APPEAL BRIEF

Mail Stop Appeal Brief – Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Appellant hereby replies to the non-final Office Action, mailed November 16, 2006. A request to reinstate the appeal is submitted herewith. Appellant's Appeal Brief in an Appeal of the final rejection of claims 1-8, 10-16, 18-26, and 28 in the above-identified patent application was submitted on May 10, 2006.

REAL PARTY IN INTEREST

The present application is assigned to Agere Systems Inc., as evidenced by a statement under 37 CFR 3.73 (b) submitted on April 16, 2006, and an assignment recorded on March 12, 2001 in the United States Patent and Trademark Office at Reel 011638, Frame 0828. The assignee, Agere Systems Inc., is the real party in interest.

RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences that will directly affect or be directly affected by or have a bearing on the decision in the present appeal.

STATUS OF CLAIMS

The present application was filed on March 12, 2001 with claims 1 through 28. Claims 9, 17, and 27 were cancelled in the Amendment and Response to Office Action dated September 17, 2004. Claims 1-8, 10-16, 18-26, and 28 are presently pending in the above-identified patent application. Claims 1, 2, 4-6, 10-12, 14-16, and 18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Nedic et al. (United States Patent Number 6,563,841; hereinafter "Nedic") in view of Haddad et al. ("Design of Digital Linear-Phase FIR Crossover Systems of Loudspeakers by the Method of Vector Space Projections," Haddad, Khalil C. et al.; hereinafter "Haddad"), claims 19, 20, 22-24, and 28 are rejected under 35 U.S.C. §103(a) as being unpatentable over Nedic in view of Haddad, and in further view of Gandhi et al. (United States Patent Number 6,112,218; hereinafter "Gandhi"), and claims 3, 7, 8, 13, 21, 25, and 26 are rejected under 35 U.S.C. §103(a) as being unpatentable over Nedic in view of Haddad, and further in view of Khalil C. ("Constrained FIR Filter Design by the Method of Vector Space Projections," Haddad, Khalil C. et al.; hereinafter "Khalil").

Claims 1, 2, 4-6, 10-12, 14-16, and 18 are also rejected under 35 U.S.C. §103(a) as being unpatentable over Haddad et al. in view of Younce et al. (United States Patent Number 5,521,908), claims 19, 20, 22-24, and 28 are rejected under 35 U.S.C. §103(a) as being unpatentable over Haddad in view of Younce, and in further view of Gandhi et al., and claims 3, 7, 8, 13, 21, 25, and 26 are rejected under 35 U.S.C. §103(a) as being unpatentable over Haddad in view of Younce, and further in view of Khalil.

Claims 1, 7, 8, 10, 11, 18, 19, 25, 26, and 28 are being appealed.

STATUS OF AMENDMENTS

There have been no amendments filed subsequent to the final rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention is directed to shortening impulse response filters (SIRF; FIG. 1: 120) that satisfy constraints in both the time and frequency domains (page 3, line 23, to page 4, line 25). In addition, methods and apparatus are disclosed for determining the coefficient values for SIRF filters (FIG. 1: 120; page 6, line 15, to page 7, line 13). The disclosed SIRF filters (FIG. 1: 120) shorten the channel impulse response in the time domain while also providing a frequency response that does not attenuate or amplify the received signal (page 2, lines 20-25). One or more sets define constraints that the SIRF filter (FIG. 1: 120) must satisfy in the time domain, and one or more sets define constraints that the SIRF filter (FIG. 1: 120) must satisfy in the frequency domain. By varying the sets utilized to define the time and frequency domain constraints, SIRF filters (FIG. 1: 120) having a linear or non-linear phase response may be obtained. The intersection of the various sets defines the coefficients for the SIRF filters (FIG. 1: 120). Vector space projection methods are utilized to determine the intersection set (page 7, line 14, to page 8, line 7).

Independent claim 1 is directed to a method (FIG. 3: 300) for determining coefficient values for a shortening impulse response filter (SIRF) (FIG. 1: 120; page 3, line 23, to page 4, line 25), comprising the steps of: establishing at least one set of defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in a time domain (page 7, lines 1-13); establishing at least one set of defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in a frequency domain (page 7, lines 1-13); and determining an intersecting set of at least one set of the defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in the time domain and at least one set of defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in the frequency domain by employing vector space projection methods (page 7, lines 1-13).

Independent claim 11 is directed to a shortening impulse response filter (SIRF) (FIG. 1: 120), comprising: a set of finite impulse response (FIR) coefficients satisfying at least one constraint in a time domain and at least one constraint in a frequency domain (page 7, lines 1-13), wherein the at least one time domain constraint is

represented as at least one first set and wherein the at least one frequency domain constraint is represented as at least one second set, wherein the finite impulse response (FIR) coefficients are determined by an intersecting set of the at least one first set defining the time domain constraints and the at least one second set defining the frequency domain constraints, wherein the intersecting set is determined by employing vector space projection methods (page 7, line 14, to page 8, line 7).

Independent claim 19 is directed to a system for determining coefficient values for a shortening impulse response filter (SIRF) (FIG. 1: 120), the system comprising: a memory that stores computer-readable code; and a processor operatively coupled to the memory, the processor configured to implement the computer-readable code, the computer-readable code configured to: establish at least one set of defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in a time domain (page 7, lines 1-13); establish at least one set of defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in a frequency domain (page 7, lines 1-13); and determine an intersecting set of the at least one set of defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in the time domain and the at least one set of defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in the frequency domain by employing vector space projection methods (page 7, lines 1-13).

In one exemplary embodiment, the at least one set of defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in the frequency domain is defined as follows:

$$C_2 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \leq |H(\omega)| \leq 1+\alpha \ \text{ for } \omega \in \Omega_p \\ \text{and } |H(\omega)| \leq \beta \text{ for } \omega \in \Omega_s \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter (FIG. 1: 120) that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band and Ω_s is the stop-

band (page 5, line 6, to page 6, line 5).

In one exemplary embodiment, the at least one set of defining constraints that the SIRF filter (FIG. 1: 120) must satisfy in the frequency domain is defined as follows:

$$C_3 \equiv \begin{Bmatrix} \mathbf{h} \in R^N : 1-\alpha \le A(\omega) \le 1+\alpha \\ \text{and } \Phi(\omega) = -\omega(N-1)/2 \text{ for } \omega \in \Omega_p \\ |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{Bmatrix}.$$

where h is the impulse response of length N of the SIRF filter (FIG. 1: 120) that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band, Ω_s is the stop-band, $A(\omega) = \sum_0^{N/2-1} 2h(n)\cos\left[\left(n - \frac{N-1}{2}\right)\omega\right]$ and $\Phi(\omega) = -\frac{N-1}{2}\omega$, wherein Φ(ω) and $A(\omega)$ are independent filter characteristics and wherein Φ(ω) is a linear phase and $A(\omega)$ is an amplitude (page 5, line 6, to page 6, line 5).

STATEMENT OF GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 2, 4-6, 10-12, 14-16, and 18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Nedic et al. in view of Haddad et al., claims 19, 20, 22-24, and 28 are rejected under 35 U.S.C. §103(a) as being unpatentable over Nedic in view of Haddad, and in further view of Gandhi et al., and claims 3, 7, 8, 13, 21, 25, and 26 are rejected under 35 U.S.C. §103(a) as being unpatentable over Nedic in view of Haddad, and further in view of Khalil.

Claims 1, 2, 4-6, 10-12, 14-16, and 18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Haddad et al. in view of Younce et al., claims 19, 20, 22-24, and 28 are rejected under 35 U.S.C. §103(a) as being unpatentable over Haddad in view of Younce, and in further view of Gandhi et al., and claims 3, 7, 8, 13, 21, 25, and 26 are rejected under 35 U.S.C. §103(a) as being unpatentable over Haddad in view of

Younce, and further in view of Khalil.

ARGUMENT

Independent Claims 1, 11 and 19

Independent claims 1 and 11 are rejected under 35 U.S.C. §103(a) as being unpatentable over Nedic in view of Haddad and claim 19 is rejected under 35 U.S.C. §103(a) as being unpatentable over Haddad in view of Younce, and in further view of Gandhi. Independent claims 1 and 11 are also rejected under 35 U.S.C. §103(a) as being unpatentable over Haddad et al. in view of Younce et al., and claim 19 is rejected under 35 U.S.C. §103(a) as being unpatentable over Haddad in view of Younce, and in further view of Gandhi. Regarding claim 1, the Examiner acknowledges that Nedic does not explicitly disclose a method of determining the values of the coefficients via vector space projection methods (VSPM), but asserts that Haddad teaches a method to solve a mathematical problem encompassing multiple constraints by vector space projection. The Examiner further asserts that, because a SIRF filter is a particular type of FIR filter, one skilled in the art would be motivated to use Haddad's exemplary coefficient determining method for SIRF filters as well as FIR filters.

Appellant notes that the concept of sets, intersection of sets and projections, and the modeling of constraints with mathematical sets are ***not*** disclosed or suggested by either Nedic or Younce. In SIRF filter design, constraints in the time domain are needed in general to prevent spectral nulls from showing up in the solution of the coefficients. Younce, for example, solves linear equations in the time domain to find the coefficients. Neither Nedic nor Younce disclose or suggest *determining an intersecting set of at least one set of defining constraints that a SIRF filter must satisfy in the time domain and at least one set of defining constraints that the SIRF filter must satisfy in the frequency domain by employing vector space projection methods*.

Appellant could also find no disclosure or suggestion in any of the cited references to combine the SIRF design disclosed by either Younce or Nedic with the method disclosed by Haddad. Independent claims 1, 11, and 19 require establishing at

least one set of defining constraints that said SIRF filter must satisfy in a time domain; establishing at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and determining an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods.

Thus, Nedic, Younce, Haddad, and Gandhi, alone or in any combination, do not disclose or suggest establishing at least one set of defining constraints that said SIRF filter must satisfy in a time domain; establishing at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and determining an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods, as required by independent claims 1, 11, and 19.

Additional Cited References

Khalil was also cited by the Examiner for its disclosure of a VSPM method wherein a filter is designed having an arbitrary magnitude and phase response.

Appellant notes that Khalil was published in August, 2000, and therefore does not constitute prior art under 35 U.S.C. §103(a) since the present application has a filing date of March 12, 2001 (Khalil is incorporated by reference in the present specification). In any case, Khalil is directed to *FIR* filter design and does ***not*** address the design of *SIRF* filters. In addition, the present specification teaches that,

> traditionally, VSPM techniques have been employed to design ***constrained FIR filters*** that are tailored to specific applications. See, K.C. Haddad, "Constrained FIR Filter Design by the Method of Vector Space Projections," IEEE Trans. on Circuit and Systems II: Analog and Digital Signal Processing, Vol. 47, No. 8 (Aug. 2000), incorporated by reference herein. In the context of the present invention, where VSPM techniques are employed to design an ***SIRF*** *filter*, ***two (or more) convex sets*** *representing the constraints in time and frequency domains and corresponding projection operators have been mathematically formulated.* A first convex set defines the constraints that the SIRF filter 120 must

> satisfy in the time domain, such that when the filter is convolved with the impulse response, the impulse response is shortened. Likewise, a second convex set defines the constraints that the SIRF filter 120 must satisfy in the frequency domain, such as a low, high or band pass band. P_i is defined to be the projection operator onto the set C_i. Thus, to obtain an SIRF filter satisfying both frequency and time constraints, an intersection of both sets is required.
> (Page 4, lines 13-25; emphasis added.)

Khalil does not disclose or suggest ***two (or more) convex sets*** *representing the constraints in time and frequency domains for SIRF filter design*.

Thus, Khalil does not disclose or suggest establishing at least one set of defining constraints that said SIRF filter must satisfy in a time domain; establishing at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and determining an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods, as required by independent claims 1, 11, and 19.

<u>Claims 7 and 25</u>

Claims 7 and 25 are rejected under 35 U.S.C. §103(a) as being unpatentable over Nedic in view of Haddad, and further in view of Kahlil, and under 35 U.S.C. §103(a) as being unpatentable over Haddad in view of Younce, and further in view of Kahlil. Regarding claim 7, the Examiner asserts that Khalil discloses the additional limitations of claim 7 (page 716, col. 1, lines 20-40; col. 2).

Appellants could find no disclosure or suggestion by Khalil that a set of defining constraints that the ***SIRF*** filter must satisfy in the frequency domain is defined as follows:

$$C_2 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le |H(\omega)| \le 1+\alpha \ \text{ for } \omega \in \Omega_p \\ \text{and } |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency

and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band and Ω_s is the stop-band

Thus, Nedic, Kapoor, Gandhi, Haddad, and Khalil, alone or in any combination, do not disclose or suggest wherein said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_2 \equiv \begin{Bmatrix} \mathbf{h} \in R^N : 1-\alpha \le |H(\omega)| \le 1+\alpha \ \text{ for } \omega \in \Omega_p \\ \text{and } |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{Bmatrix}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band and Ω_s is the stop-band, as required by claims 7 and 25.

<u>Claims 8 and 26</u>

Claims 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Nedic in view if Haddad, and further in view of Kahlil, and under 35 U.S.C. §103(a) as being unpatentable over Haddad in view of Younce, and further in view of Kahlil. Regarding claim 8, the Examiner asserts that Khalil discloses the additional limitations of claim 8 (page 716, col. 1, lines 20-40; col. 2).

Appellants could find no disclosure or suggestion by Khalil that a set of defining constraints that the ***SIRF*** filter must satisfy in the frequency domain is defined as follows:

$$C_3 \equiv \begin{Bmatrix} \mathbf{h} \in R^N : 1-\alpha \le A(\omega) \le 1+\alpha \\ \text{and } \Phi(\omega) = -\omega(N-1)/2 \ \text{ for } \omega \in \Omega_p \\ |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{Bmatrix}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency

and time domain, respectively, $H(\omega)$ is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band, Ω_s is the stop-band, $A(\omega)=\sum_{0}^{N/2-1} 2h(n)\cos\left[\left(n-\frac{N-1}{2}\right)\omega\right]$ and $\Phi(\omega)=-\frac{N-1}{2}\omega$, wherein $\Phi(\omega)$ and $A(\omega)$ are independent filter characteristics and wherein $\Phi(\omega)$ is a linear phase and $A(\omega)$ is an amplitude.

Thus, Nedic, Kapoor, Gandhi, Haddad, and Khalil, alone or in any combination, do not disclose or suggest wherein said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_3 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le A(\omega) \le 1+\alpha \\ \text{and } \Phi(\omega) = -\omega(N-1)/2 \text{ for } \omega \in \Omega_p \\ |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{array} \right\}$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, $H(\omega)$ is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band, Ω_s is the stop-band, $A(\omega)=\sum_{0}^{N/2-1} 2h(n)\cos\left[\left(n-\frac{N-1}{2}\right)\omega\right]$ and $\Phi(\omega)=-\frac{N-1}{2}\omega$, wherein $\Phi(\omega)$ and $A(\omega)$ are independent filter characteristics and wherein $\Phi(\omega)$ is a linear phase and $A(\omega)$ is an amplitude, as required by claims 8 and 26.

Conclusion

The rejections of the independent claims under section 103 in view of Nedic, Younce, Gandhi, Khalil, and Haddad, alone or in combination, are therefore believed to be improper and should be withdrawn. The remaining rejected dependent claims are believed allowable for at least the reasons identified above with respect to the independent claims.

The attention of the Examiner and the Appeal Board to this matter is appreciated.

Respectfully submitted,

Date: February 15, 2007

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APPENDIX

1. A method for determining coefficient values for a shortening impulse response filter (SIRF), said method comprising the steps of:

establishing at least one set of defining constraints that said SIRF filter must satisfy in a time domain;

establishing at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and

determining an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods.

2. The method according to claim 1, wherein said at least one set of defining constraints that said SIRF filter must satisfy in the time domain define a filter having a linear phase response.

3. The method according to claim 1, wherein said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain define a filter having a non-linear phase response.

4. The method according to claim 1, wherein the time domain constraints specify a shortening of a channel impulse response.

5. The method according to claim 1, wherein the frequency domain constraints include a frequency response for said SIRF filter that does not attenuate a received signal.

6. The method according to claim 1, wherein the frequency domain constraints include a pass-band for said SIRF filter.

7. The method according to claim 2, wherein said at least one set of defining constraints that the SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_2 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le |H(\omega)| \le 1+\alpha \ \text{ for } \omega \in \Omega_p \\ \text{and } |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band and Ω_S is the stop-band

8. The method according to claim 3, wherein said at least one set of defining constraints that the SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_3 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le A(\omega) \le 1+\alpha \\ \text{and } \Phi(\omega) = -\omega(N-1)/2 \ \text{ for } \omega \in \Omega_p \\ |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{array} \right\}$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band, Ω_S is the stop-band, $A(\omega) = \sum_{0}^{N/2-1} 2h(n)\cos\left[\left(n - \frac{N-1}{2}\right)\omega\right]$ and $\Phi(\omega) = -\frac{N-1}{2}\omega$, wherein Φ(ω) and $A(\omega)$ are independent filter characteristics and wherein Φ(ω) is a linear phase and $A(\omega)$ is an

amplitude.

9. (Cancelled)

10. The method according to claim 1, wherein said vector space projection method is iteratively applied to said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain until the sets converge to a set of coefficients satisfying said time domain constraints and said frequency domain constraints.

11. A shortening impulse response filter (SIRF), comprising:

a set of finite impulse response (FIR) coefficients satisfying at least one constraint in a time domain and at least one constraint in a frequency domain, wherein said at least one time domain constraint is represented as at least one first set and wherein said at least one frequency domain constraint is represented as at least one second set, wherein said finite impulse response (FIR) coefficients are determined by an intersecting set of said at least one first set defining said time domain constraints and said at least one second set defining said frequency domain constraints, wherein said intersecting set is determined by employing vector space projection methods.

12. The SIRF according to claim 11, wherein said at least one first set defining constraints that said SIRF filter must satisfy in a time domain define a filter having a linear phase response.

13. The SIRF according to claim 11, wherein said at least one second set defining constraints that said SIRF filter must satisfy in a frequency domain define a filter having a non-linear phase response.

14. The SIRF according to claim 11, wherein the time domain constraints specify a shortening of a channel impulse response.

15. The SIRF according to claim 11, wherein the frequency domain constraints include a frequency response for said SIRF filter that does not attenuate a received signal.

16. The SIRF according to claim 11, wherein the frequency domain constraints include a pass-band for said SIRF filter

17. (Cancelled)

18. The SIRF according to claim 11, wherein said vector space projection method is iteratively applied to said at least one first set defining said time domain constraints and said at least one second set defining said frequency domain constraints until the sets converge to a set of coefficients satisfying said time domain constraints and said frequency domain constraints.

19. A system for determining coefficient values for a shortening impulse response filter (SIRF), said system comprising:

a memory that stores computer-readable code; and

a processor operatively coupled to said memory, said processor configured to implement said computer-readable code, said computer-readable code configured to:

establish at least one set of defining constraints that said SIRF filter must satisfy in a time domain;

establish at least one set of defining constraints that said SIRF filter must satisfy in a frequency domain; and

determine an intersecting set of said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining

constraints that said SIRF filter must satisfy in the frequency domain by employing vector space projection methods.

20. The system according to claim 19, wherein said at least one set of defining constraints that said SIRF filter must satisfy in the time domain define a filter having a linear phase response

21. The system according to claim 19, wherein said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain define a filter having a non-linear phase response.

22. The system according to claim 19, wherein the time domain constraints specify a shortening of a channel impulse response.

23. The system according to claim 19, wherein the frequency domain constraints include a frequency response for said SIRF filter that does not attenuate a received signal.

24. The system according to claim 19, wherein the frequency domain constraints include a pass-band for said SIRF filter.

25. The system according to claim 20, wherein said at least one set of defining constraints that the SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_2 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \leq |H(\omega)| \leq 1+\alpha \ \text{ for } \omega \in \Omega_p \\ \text{and } |H(\omega)| \leq \beta \text{ for } \omega \in \Omega_s \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse

response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band and Ω_S is the stop-band.

26. The system according to claim 21, wherein said at least one set of defining said domain constraints that the SIRF filter must satisfy in the frequency domain is defined as follows:

$$C_3 \equiv \left\{ \begin{array}{l} \mathbf{h} \in R^N : 1-\alpha \le A(\omega) \le 1+\alpha \\ \text{and } \Phi(\omega) = -\omega(N-1)/2 \text{ for } \omega \in \Omega_p \\ |H(\omega)| \le \beta \text{ for } \omega \in \Omega_s \end{array} \right\}.$$

where h is the impulse response of length N of the SIRF filter that shortens the impulse response of a channel, ω is a frequency, α and β are error tolerance regions of frequency and time domain, respectively, H(ω) is the impulse response in the frequency domain, R^N is the Hilbert space of dimension N, Ω_p is the pass-band, Ω_S is the stop-band, $A(\omega) = \sum_0^{N/2-1} 2h(n)\cos\left[\left(n - \frac{N-1}{2}\right)\omega\right]$ and $\Phi(\omega) = -\frac{N-1}{2}\omega$, wherein Φ(ω) and $A(\omega)$ are independent filter characteristics and wherein Φ(ω) is a linear phase and $A(\omega)$ is an amplitude.

27. (Cancelled)

28. The system according to claim 19, wherein said vector space projection method is iteratively applied to said at least one set of defining constraints that said SIRF filter must satisfy in the time domain and said at least one set of defining constraints that said SIRF filter must satisfy in the frequency domain until the set of defining constraints that said SIRF filter must satisfy in the time domain converge to a set of coefficients satisfying said time domain constraints and the set of defining constraints

that said SIRF filter must satisfy in the frequency domain converge to a set of coefficients satisfying said frequency domain constraints.

EVIDENCE APPENDIX

There is no evidence submitted pursuant to § 1.130, 1.131, or 1.132 or entered by the Examiner and relied upon by appellant.

RELATED PROCEEDINGS APPENDIX

There are no known decisions rendered by a court or the Board in any proceeding identified pursuant to paragraph (c)(1)(ii) of 37 CFR 41.37.